# Colour-blind drivers' perception of traffic signals

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**There is a dangerous and widespread assumption that colour-blind drivers drive as safely as drivers with normal vision. Colour-blind drivers have difficulties recognizing traffic and vehicle signals. However, simple and practical solutions such as changes to the design, colour and shape of signals will aid these drivers.**

**Il existe une présomption dangereuse et répandue à l'effet que les conducteurs daltoniens conduisent de façon aussi sécuritaire que les conducteurs ayant une vue normale. Les conducteurs daltoniens ont de la difficulté à reconnaître les feux de circulation et les feux de signalisation des véhicules. Toutefois, des solutions simples et pratiques telles que des changements dans la conception, la couleur et la forme des feux aideront ces conducteurs.**

There is an almost world-wide assumption that colour-blind† drivers can "read" the familiar three-colour arrangement of traffic signals. Medical advice to traffic authorities has been consistently reassuring that colour-blind drivers may be given unrestricted licences.[1] But, for reasons that are not clear, this reassurance does not extend to drivers of heavy commercial vehicles, taxis or buses, indicating some doubt about colour blindness in drivers.

Colour blindness occurs in 8% of males, who are affected 10 times oftener than females. I estimate that there are over 500 000 drivers in Canada who have some difficulty in recognizing colours, particularly reds and greens. Some of these drivers, perhaps many, are not aware of their disability and the problems it may pose in driving. Drivers with red blindness (protanopia) may not see a red signal until it is close. Dalton,[2] in his 1794 monograph, stated "that part of the image which others call red appears to me little more than a shade or defect of light". Studies have shown that colour-blind subjects take longer to recognize signal colours than subjects with normal vision and make twice as many errors in doing so.[3,4] The available stopping distance for red-blind drivers facing a red light may be dangerously reduced, by as much as 39% to 100%, and most markedly in bright sunlight.[5]

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†This term is used here to denote all grades and types of colour-defective vision.

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I surveyed two groups of colour-blind drivers, one through a formal questionnaire and the other through informal interviews and correspondence. In addition, I tested simulated traffic signals using subjects with normal vision and others who were colour-blind.

## Methods

The questionnaire was developed with the assistance of the driver examination centre of the motor vehicles branch, British Columbia Ministry of Transportation and Highways. The forms were distributed to various driver examination centres in British Columbia and were given to successful applicants for a driver's licence who had failed to pass the colour-vision test. Completion of the forms in the examination centres was voluntary, and individuals were informed that if they wished to remain anonymous they could omit their names and addresses.

The interviewing and correspondence was conducted over a 12-month period with 17 colour-blind drivers.

For the signal recognition tests I used three light boxes with frosted screens lit by 100-W bulbs. Of the 10 subjects 5 had normal vision and 5 were colour-blind. Various masks and coloured filters were placed in front of the screens to simulate possible shapes for traffic signals. The mean diameter of the simulated signals was 12 cm, and the viewing distance was 10 m. The tests were informal, and the subjects simply stated their preference for particular signals. In the course of more than 150 tests the preferences for various signals were ascertained for each subject and for the subjects as a group.

## Results

All 18 of the questionnaire respondents were men; they ranged in age from 16 to 50 years and had a mean age of 27 years. Driving experience for many was limited, and some had not known that they were colour-blind until the licence tests. Two did not know or did not state which colours they could not identify. None admitted to any difficulties in reading traffic signals, though six suggested changes in signal design that would aid recognition.

Of the 17 colour-blind drivers with whom I conducted informal interviews or correspondence 15 were men, and their mean age was 51 years, nearly twice that of those answering the questionnaire. Their comments are summarized in Table I. All but one admitted to difficulties with traffic signals, one admitted to a previously unde-

clared accident due to his colour blindness, and all but one offered suggestions for improving signal recognition. Nearly all reported confusion with street and signal lights, and confusion between the red and amber signals was common. According to some comments drivers find colour blindness more of a problem when they are tired.

In the signal recognition tests shaped signals were preferred by all five colour-blind subjects; none of the subjects with normal vision found these inferior to the standard designs. All 10 subjects stated that signals were more distinctive when framed by white light or when crossed by a white bar.

## Discussion

Officials concerned with licensing drivers are unlikely to be aware of problems faced by colour-blind drivers. Drivers who have failed the colour-vision tests are not identified in the licensing data, and colour-vision abnormality is not noted on drivers' licences. Some drivers, knowing that they can be denied certain types of licences if they are found to be colour-blind, will be apprehensive about taking a colour-vision test, and this could affect the results. No doubt a recently successful applicant for a driver's licence would be unlikely to volunteer information about driving difficulties. Colour-blind drivers involved in accidents would not likely volunteer information about their disability either, and police officers do not routinely ask about colour blindness; therefore, there are no relevant statistics. Although the comments I obtained from colour-blind drivers were unlikely to have been influenced by fear of disclosure, perhaps serious accidents caused by colour blindness were not mentioned for reasons of embarrassment.

Not only are accident statistics related to colour blindness difficult to obtain, but also the results of one study that was well done have been misinterpreted. Norman[6] showed that London bus drivers who were colour-blind had no more accidents than drivers with normal vision. These professional drivers were travelling on familiar roads, and Norman's cautionary statement that his study may not apply to other drivers is often ignored. Of course, it is the amateur driver who is more likely to be driving through unfamiliar intersections and more apt to drive unwisely or too long.

Warning colour-blind drivers about difficulties they may encounter with coloured signals is akin to warning blind people to stop when they see a red light. Filters to be worn as spectacles have been proposed to aid the colour-blind driver, but their usefulness has yet to be demonstrated.

Traffic authorities have at least partially recognized problems faced by colour-blind drivers: warning flashing signals ahead of traffic intersections are used on highways; the wavelength of the red and green signals has been shifted so the red appears more orange and the green more blue; standardized signal positions and sequences are in general use; and the red or stop signal is sometimes larger.

Undoubtedly these measures are valuable. But if the comments I received are to be believed, serious difficulties remain. Single flashing lights may be red, green or amber. Signal positions may be over the centre of intersections, on both sides or on only one side, and they may even be arranged horizontally. In Quebec and Nova Scotia shape-coded signals have been successfully used for some years. But the red-blind driver still may not be able to see the red signal in sufficient time.

Shape-coding has been successfully applied to traffic signs. The critically important "STOP" sign, a red octagon outlined in white, apparently presents no problems for even the most severely colour-blind drivers.

Shirley and Gauthier[7] studied turn signals for vehicles and shape-coded traffic signals by testing 52 colour-blind men. Amber turn signals were mistaken for red, and white signals were mistaken for green, but shaped traffic signals were rarely mistaken. They concluded that amber flashing turn signals were not safe for colour-blind drivers and that traffic signals should be shape-coded and increased in brightness.

Table I—Summary of comments of colour-blind drivers

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|---|
| I am confused by single blinking amber or red lights. I was told by the examiner that I would lose my licence if I had an accident connected to traffic lights and was at fault. |
| The green signal looks white, like the other city lights, and this is confusing. I don't know whether it is the green until the amber or the red comes on. When the sun is behind the signals the lights all blend and I cannot distinguish red and amber. The green, however, shows up then. |
| I am confused when the light is poor (i.e., in the late evening or at night). |
| I drive on the assumption that when I don't see the green (which to me looks white) it must be red, which I cannot see. On the other hand, leaving amber (which I see quite well) along with green would be confusing to me, as I would not know any warning. |
| I get confused between amber and red signals. I have difficulty distinguishing green signals from street lights. |
| Often I must stop and work things out. Direct light clouds my ability to distinguish which signal is lit. |
| At night I have difficulty differentiating between green signals and mercury vapour street lights. |
| I cannot distinguish traffic signals at night on a street with many neon lights until I am close. I have had one accident attributable to colour blindness. |
| I find it hard to locate the traffic lights. The problem is twice as bad at Christmas . . . As to the red light, there is a time lag before I see it; indeed, I may not see it at all as a light. I have to get close to recognize it as a light. I do not recognize red as red beyond 200 yards. I have run through red lights without being aware of them. Lights are not always in a standard position. I have trouble with trailing lights. The flashing turn signal in the car ahead isn't apparent to me. |
| I am often unaware that there is a traffic light at an unfamiliar intersection until it turns amber or red. |
| I don't have any real trouble. I can't tell reds from greens at sea, but I can on streets. My son has had troubles with traffic lights and has been warned that he may lose his licence. |
| I have no problem on familiar streets because I know where the signals are located. I keenly watch cars waiting in the cross direction. If they move I presume that I may be encountering a red signal. Away from familiar areas I am very, very careful at night. The green signal is more difficult than the red. |
| I have to watch what other drivers do, so I am very cautious. It is a dangerous nuisance. The lights are not standardized. There are single flashing lights, which are no help whatever. The colour-vision testing is a joke. What does it signify for drivers' licences? It seems to me that my colour perception is poorer in the evening. |

Although the rapid replacement of car and traffic signals would be expensive, the costs could be limited if changes were made only when signals needed replacement for other reasons.

## Conclusion

Since no accident statistics related to colour-blind drivers are available, the conclusion has been made that colour-blind drivers compensate well and drive as safely as drivers with normal vision. This conclusion is unjustified. It is essential that studies be undertaken, preferably by traffic authorities with medical advice, to determine the best designs for traffic and vehicle signals. Meanwhile medical advice to traffic engineers should reflect the difficulties faced by colour-blind drivers.

I gratefully acknowledge the advice and support of various members of the Committee on Behalf of Colour Blind Drivers, of Mr. Glen Barter and Mr. Glen Standen, driver examination centre, motor vehicles branch, BC Ministry of Transportation and Highways, and of Dr. Don McKerricher, MD, FRCS, Nanaimo, BC.

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# Comparison of natural and synthetic prostaglandin $E_2$ tablets in labour induction

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**A multicentre, randomized, double-blind trial compared the efficacy and safety of and tolerance to natural and synthetically produced prostaglandin $E_2$ tablets in the induction of labour in 202 women. The compounds were similarly effective, inducing labour in approximately 66% of patients. The total dose required and the interval between induction and delivery were similar in the two groups, as were the Apgar scores at 1 and 5 minutes and the incidence of maternal and fetal side effects.**

**Une étude multicentres, randomisée et à double-insu a comparé l'efficacité et la sûreté de et la tolérance à comprimés de prostaglandine $E_2$ naturelle ou synthétique dans le déclenchement du travail chez 202 femmes. Les composés étaient d'efficacité semblable, déclenchant le travail chez environ 66% des patientes. La dose totale nécessaire et l'intervalle entre le déclenchement du travail et l'accouchement étaient similaires pour les deux groupes, de même que l'indice d'Apgar à 1 et à 5 minutes et la fréquence des effets secondaires maternels et foetaux.**

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Prostaglandin $E_2$ ($PGE_2$) tablets have been used since 1971 to induce labour at term.[1] The active ingredient of $PGE_2$, dinoprostone, is obtained from the coral *Plexaura homomala* (or sea whiff), which is found in the Caribbean. Recently a synthetic method of manufacturing dinoprostone has been developed, and the product has been shown to be chemically and physically equivalent to that extracted from the coral. We compared the efficacy and safety of and tolerance to natural $PGE_2$, that extracted from coral, with that produced synthetically.

## Methods and materials

This was a double-blind, prospective, multicentre study of 202 women with singleton pregnancies with the participants randomly allocated to receive natural or synthetic $PGE_2$ within each centre. Patients were considered suitable for the study if there were no medical or obstetric contraindications to labour induction, vaginal